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Biofeedback treatment of buccofacial apraxia using EMA

William F. Katz,[a] June S. Levitt,[a] and Gregory C. Carter[b]

[a] *The University of Texas at Dallas, Callier Center for Communication Disorders, USA*
[b] *The University of Texas Southwestern Medical Center at Dallas, USA*

EMA (electromagnetic midsagittal articulography) is a fleshpoint tracking system that measures articulatory movement using low field-strength, alternating electromagnetic fields. EMA is primarily a research tool, however it has also recently been used to provide visual biofeedback treatment of speech errors in adults with apraxia and aphasia (Katz, Bharadwaj, & Carstens, 1999; Katz, Bharadwaj, Gabbert, & Stettler, 2002). The present study investigates a novel EMA biofeedback system designed to treat buccofacial (oral) apraxia. An individual with Broca's aphasia and apraxia and a normal control subject completed a nonspeech oral motor task (touching the lips in alternating fashion with the tongue tip) under EMA biofeedback conditions. Preliminary results indicate EMA can provide a useful means of monitoring and training lingual behavior in apraxic adults.

Methods

Participants

A1 is a 65-year-old, male, monolingual speaker of American English who suffered a left-hemisphere CVA in 1991. Based on clinical examination and testing on the BDAE (Goodglass & Kaplan, 1983) he was classified as a Broca's aphasic. A1 presented with severe apraxia of speech (AOS) and mild-to-moderate oral apraxia (as tested on the ABA-2; Dabul, 2000). Testing on the Frenchay Dysarthria Assessment (Enderby, 1983) revealed performance close to normal limits for the lips, jaw, palate, and laryngeal subsystems, but substantial difficulty with tongue mobility. The control subject, C1 is a 26-year-old, female, speaker of American English with no reported history of speech, hearing, or language disorders.

Procedure

Each subject participated in a single biofeedback session lasting approximately 45 min. In the biofeedback procedure, the subject was seated in a sound-treated room wearing the articulograph helmet. A receiver coil was attached to the tongue tip. The subject faced a video monitor that displays an image of his/her current tongue position, marked with a large 'X.' The video monitor also displayed a trace marking the recent path of tongue movement. Investigators first designated two target zones corresponding with each subject's accurate placement of the tongue tip on the upper lip and on the lower lip. The computer used this information to guide tongue movements during training.

The subject's goal was to 'hit the targets' displayed on the monitor. Each time a target was hit, a tone was heard and a visual reward (i.e., a rising balloon) moved on the monitor. During these trials, the target zones to be hit lit up green, indicating the subject should move the tongue-tip coil into that region. Immediately after this target zone was hit, it turned red, and the alternate target lit up green. In this fashion, immediate feedback for spatial positioning of the tongue was provided. Subjects were required to successfully hit all target zones successively displayed on the monitor before being thanked (by the computer) for finishing each task. Subjects first completed two short training sets to familiarize them with the biofeedback procedure. They then completed seven blocks of 20 training trials, for a total of 280 tongue-to-lip movements (=7 blocks $\times$ 20 trials $\times$ 2 lip movements per trial). Kinematic data were recorded direct to disk for later analysis.

Results

Fig. 1 shows examples of tongue tip movement taken from the first (left panels) and last (right panels) biofeedback trials for each talker. Data for normal control talker C1 are shown on the top, and for aphasic/apraxic talker A1 on the bottom. Each panel shows cumulative movement for 20 successive tongue-to-lip movements (upper lip, lower lip) in each training block. Small circles denote the target zones that were designated by the experimenters at the start of each session (based on each speaker's correct movements). A large, outer circle marks the "active area" required to activate targets. An 'X' shows the tongue tip position at the end of the session.

For C1, tongue movement was accomplished smoothly, with little apparent difference between the first and last training blocks. In contrast, A1 showed evidence of groping and incomplete movement attempts in the first training block, with less extensive and more refined movement by the final training block.

Discussion

Although preliminary, the results suggest: (1) tongue movements for nonspeech gestures may be effectively analyzed using EMA, and (2) EMA biofeedback can be used to train oral apraxic talkers, with apparent success. However, these claims must be tested with larger subject groups and with appropriate controls before any firm conclusions can be drawn. Future studies should also investigate whether the gains from EMA biofeedback treatment demonstrate long-term maintenance, and whether improvement generalizes to other forms of oral motor behavior.

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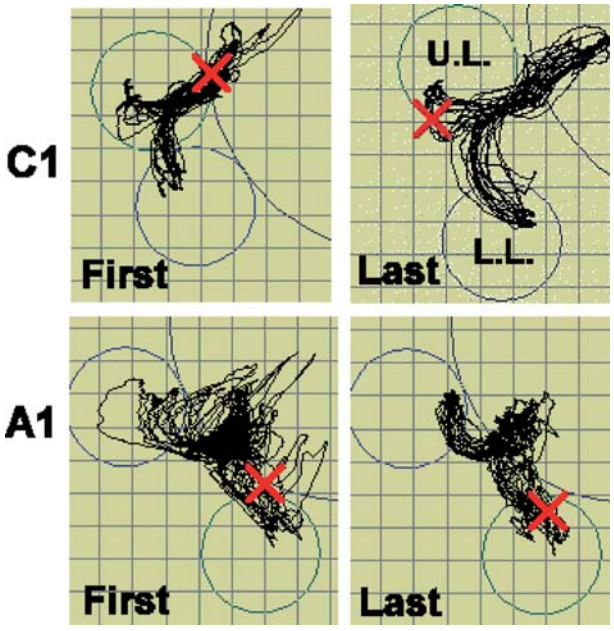

Fig. 1. Examples of tongue tip movement taken from first and last biofeedback trials for each talker (C1, control and A1, aphasic/aproxic).

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